



# HALL-PAK MULTIPLIERS SPECIFICATIONS

HM-3000  
SERIES

|                                                           |                           |                                         |                |                |                |           |               |
|-----------------------------------------------------------|---------------------------|-----------------------------------------|----------------|----------------|----------------|-----------|---------------|
| Type 3 - not compensated                                  | HM-3013                   | HM-3023                                 | HM-3033        | HM-3043        | HM-3053        | Unit 1)   |               |
| Type 2 - temperature compensated                          | HM-3012                   | HM-3022                                 | HM-3032        | HM-3042        | HM-3052        |           |               |
| Type 1 - error voltages compensated                       | HM-3011                   | HM-3021                                 | HM-3031        | HM-3041        | HM-3051        |           |               |
| Type 0 - completely compensated                           | HM-3010                   | HM-3020                                 | HM-3030        | HM-3040        | HM-3050        |           |               |
| <u>Magnetic Field Input</u>                               |                           | data for parallel connected field coils |                |                |                |           |               |
| Resistance, approx.                                       | $R_f$                     | .06                                     | .5             | 5              | 50             | 500       | $\Omega$      |
| Temperature influence on $R_f$                            |                           | + .39                                   | + .39          | + .39          | + .39          | + .39     | %/°C          |
| Reactance, approx.                                        | $X_f$                     | 4                                       | 40             | 400            | 4000           | 40000     | $\Omega$ /kHz |
| Current rating                                            | $I_{fmax}$                | <u>3000</u>                             | <u>1000</u>    | <u>300</u>     | <u>100</u>     | <u>30</u> | mA            |
| Practical freq. range at $I_{fmax}$                       | dc to                     | 1                                       | 1              | 1              | .75            | .25       | kHz           |
| <u>Hall Input</u>                                         |                           | <u>all models</u>                       |                |                |                |           |               |
| Resistance, approx. at $I_f = 0$                          | $R_{in}$                  | 2.5                                     |                |                |                |           | $\Omega$      |
| Temperature influence on $R_{in}$ , approx.               |                           | + .15                                   |                |                |                |           | %/°C          |
| Magneto resistance at $I_{fmax}$                          | $\rho_B \sim I_f^2$       | <+25                                    |                |                |                |           | % of $R_{in}$ |
| Current rating                                            | $I_{cmax}$                | <u>330</u>                              |                |                |                |           | mA            |
| Practical frequency range                                 | dc to                     | 500                                     |                |                |                |           | kHz           |
| <u>Hall Output</u>                                        |                           | Type 0                                  | Type 1         | Type 2         | Type 3         |           |               |
| Resistance, approx.                                       | $R_{out}$                 | 10                                      | 2.5            | 10             | 2.5            |           | $\Omega$      |
| Load resistance                                           | $R_l$                     | 50                                      | >30            | 50             | >30            |           | $\Omega$      |
| Output at max. inputs                                     | $V_H \sim I_f \times I_c$ | <u>&gt;200</u>                          | <u>&gt;250</u> | <u>&gt;200</u> | <u>&gt;250</u> |           | mV            |
| Temperature influence on $V_H$ ,<br>-ambient 0°C to +50°C |                           | <±.5                                    | <±3            | <±.5           | <±3            |           | %             |
| -ambient -25°C to +75°C                                   |                           | <±1                                     | <±6            | <±1            | <±6            |           | %             |
| <u>Hall Output vs. Field Input</u>                        |                           |                                         |                |                |                |           |               |
| Linearity error, at constant $I_c$                        | $F_{fs}$                  | <.5                                     | <.5            | <.5            | <.5            |           | % FS          |
| Remanent residual after $I_f$ dc max to 0                 |                           | <.5                                     | <.5            | <.5            | <.5            |           | % FS          |
| Phase shift, approx.                                      | $V_H$ lags $I_f$          | 3                                       | 3              | 3              | 3              |           | deg/kHz       |
| Frequency response, approx.                               |                           | -.3                                     | -.3            | -.3            | -.3            |           | dB/kHz        |
| Inductive error voltage at $I_{fmax}$                     | $V_{B2} \sim I_f$         | <.1                                     | <.1            | <.6            | <.6            |           | mV/kHz        |
| <u>Hall Output vs. Hall Input</u>                         |                           |                                         |                |                |                |           |               |
| Linearity error, at constant $I_f$                        | $F_{fs}$                  | <.25                                    | <.25           | <.25           | <.25           |           | % FS          |
| Resistive error voltage at $I_{cmax}$                     | $V_M \sim I_c$            | <.1                                     | <.1            | <.5            | <.5            |           | mV            |
| Thermal error voltage at $I_{cmax}$                       | $V_T \sim I_c^2$          | <.2                                     | <.2            | <.6            | <.6            |           | mV dc         |

NOTES 1) Data is at 25°C. ac values are rms. kHz (kilohertz) = kc/s.

2) For series connected coils  $R_f = 4x$ ,  $X_f = 4x$  and  $I_{fmax} = .5x$  values shown.

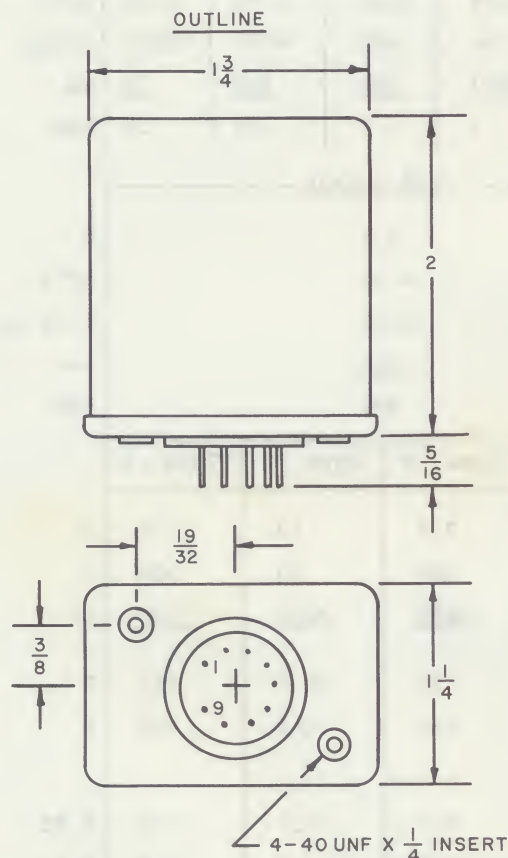
Underlined models are standard stock items.



HM-3000 Series Hall-Pak Multipliers consist of a Hall element located in the gap of a laminated silicon steel core with two identical field coils. A current flowing through the coils generates a magnetic field in the gap. The Hall element is a magneto sensitive semiconductor with four terminals, providing a voltage proportional to the product of the magnetic field in which it is placed and the current flowing through it. The output voltage of the multiplier is therefore proportional to the product of the field input current and the Hall input current.

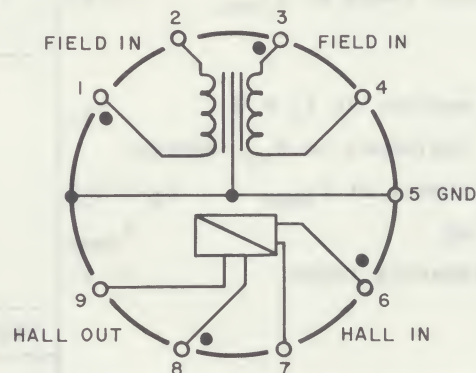
HM-3000 Series Multipliers are epoxy potted in a hermetically sealed steel case 2" x 1-3/4" x 1-1/4" with a 9-pin standard miniature glass seal header and two 4-40 UNF x 1/4" mounting inserts. Weight 6 oz.

Typical applications are: analog multiplier, dc to ac convertor, chopper, function generator, squarer, level regulator, modulator, discriminator, dc and ac wattmeter.



## SCHEMATIC

PARALLEL COILS: SHORT 1-3 & 2-4  
SERIES COILS: SHORT 2-3



Electrically equivalent models are available in the HQ-3100 Series, featuring a nylon-phenolic case with leads for printed circuit board mounting, and, on special order, in the HM-3200 Series, featuring a glass seal header with solder terminals and two 6-32 x 11/32" mounting studs.

Models HM-3010, -3030, and -3050 will be supplied in a 2-7/8" high case until the current stock is depleted.

Points to consider in Hall multiplier applications:

1. The Hall output voltage is proportional to the product of the input currents. The input currents must therefore be proportional to the quantities to be multiplied.
2. The field input circuit is reactive. Maximum driving power is approximately .5 W. Maximum driving VA is determined by the highest frequency in the input signal.
3. The Hall input circuit is resistive. Maximum driving power is approximately .25 W. A high impedance source will reduce the influence of temperature and magneto resistance.
4. The field input circuit is isolated from the Hall circuits. The core ground provides electrostatic shielding.
5. The Hall input circuit is not isolated from the Hall output circuit. Only one of these two circuits can be grounded.

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# HALL-PAK MULTIPLIERS

HQ-3100  
SERIES

|                                     |         |         |                |         |                |                    |
|-------------------------------------|---------|---------|----------------|---------|----------------|--------------------|
| Type 3 - not compensated            | HQ-3113 | HQ-3123 | <u>HQ-3133</u> | HQ-3143 | <u>HQ-3153</u> | Unit <sup>1)</sup> |
| Type 2 - temperature compensated    | HQ-3112 | HQ-3122 | HQ-3132        | HQ-3142 | HQ-3152        |                    |
| Type 1 - error voltages compensated | HQ-3111 | HQ-3121 | HQ-3131        | HQ-3141 | HQ-3151        |                    |
| Type 0 - completely compensated     | HQ-3110 | HQ-3120 | HQ-3130        | HQ-3140 | HQ-3150        |                    |

| <u>Magnetic Field Input</u>         |            | data for parallel connected field coils |             |            |            |           | Unit <sup>2)</sup>  |
|-------------------------------------|------------|-----------------------------------------|-------------|------------|------------|-----------|---------------------|
|                                     |            |                                         |             |            |            |           |                     |
| Resistance, approx.                 | $R_f$      | .06                                     | .5          | 5          | 50         | 500       | $\Omega$            |
| Temperature influence on $R_f$      |            | +39                                     | +39         | +39        | +39        | +39       | %/°C                |
| Reactance, approx.                  | $X_f$      | 4                                       | 40          | 400        | 4000       | 40000     | $\Omega/\text{kHz}$ |
| Current rating                      | $I_{fmax}$ | <u>3000</u>                             | <u>1000</u> | <u>300</u> | <u>100</u> | <u>30</u> | mA                  |
| Practical freq. range at $I_{fmax}$ | dc to      | 1                                       | 1           | 1          | .75        | .25       | kHz                 |

| <u>Hall Input</u>                           |                     | all models |  |            |  |  | Unit          |
|---------------------------------------------|---------------------|------------|--|------------|--|--|---------------|
|                                             |                     |            |  |            |  |  |               |
| Resistance, approx. at $I_f = 0$            | $R_{in}$            |            |  | 2.5        |  |  | $\Omega$      |
| Temperature influence on $R_{in}$ , approx. |                     |            |  | +15        |  |  | %/°C          |
| Magneto resistance at $I_{fmax}$            | $\rho_B \sim I_f^2$ |            |  | <+25       |  |  | % of $R_{in}$ |
| Current rating                              | $I_{cmax}$          |            |  | <u>330</u> |  |  | mA            |
| Practical frequency range                   | dc to               |            |  | 500        |  |  | kHz           |

| <u>Hall Output</u>                                        |                           | Type 0 | Type 1 | Type 2 | Type 3 | Unit     |
|-----------------------------------------------------------|---------------------------|--------|--------|--------|--------|----------|
|                                                           |                           |        |        |        |        |          |
| Resistance, approx.                                       | $R_{out}$                 | 10     | 2.5    | 10     | 2.5    | $\Omega$ |
| Load resistance                                           | $R_L$                     | 50     | >30    | 50     | >30    | $\Omega$ |
| Output at max. inputs                                     | $V_H \sim I_f \times I_c$ | >200   | >250   | >200   | >250   | mV       |
| Temperature influence on $V_H$ ,<br>-ambient 0°C to +50°C |                           | <±.5   | <±3    | <±.5   | <±3    | %        |
| -ambient -25°C to +75°C                                   |                           | <±1    | <±6    | <±1    | <±6    | %        |

| <u>Hall Output vs. Field Input</u>        |                   | Type 0 | Type 1 | Type 2 | Type 3 | Unit    |
|-------------------------------------------|-------------------|--------|--------|--------|--------|---------|
|                                           |                   |        |        |        |        |         |
| Linearity error, at constant $I_c$        | $F_{fs}$          | <.5    | <.5    | <.5    | <.5    | % FS    |
| Remanent residual after $I_f$ dc max to 0 |                   | <.5    | <.5    | <.5    | <.5    | % FS    |
| Phase shift, approx.                      | $V_H$ lags $I_f$  | 3      | 3      | 3      | 3      | deg/kHz |
| Frequency response, approx.               |                   | -.3    | -.3    | -.3    | -.3    | dB/kHz  |
| Inductive error voltage at $I_{fmax}$     | $V_{B2} \sim I_f$ | <.1    | <.1    | <.6    | <.6    | mV/kHz  |

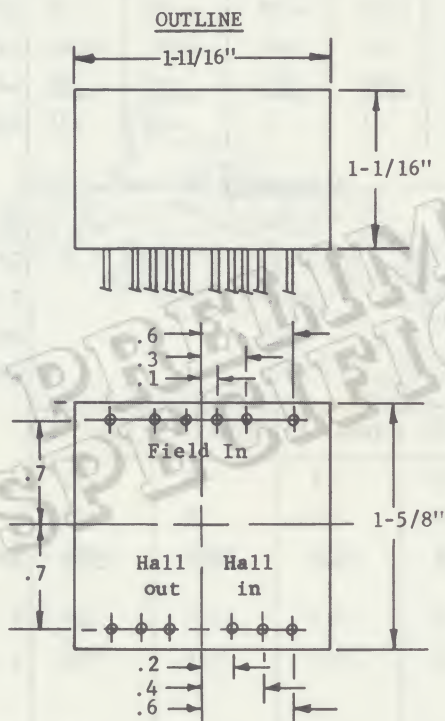
| <u>Hall Output vs. Hall Input</u>     |                  | Type 0 | Type 1 | Type 2 | Type 3 | Unit  |
|---------------------------------------|------------------|--------|--------|--------|--------|-------|
|                                       |                  |        |        |        |        |       |
| Linearity error, at constant $I_f$    | $F_{fs}$         | <.25   | <.25   | <.25   | <.25   | % FS  |
| Resistive error voltage at $I_{cmax}$ | $V_M \sim I_c$   | <.1    | <.1    | <.5    | <.5    | mV    |
| Thermal error voltage at $I_{cmax}$   | $V_T \sim I_c^2$ | <.2    | <.2    | <.6    | <.6    | mV dc |

NOTES 1) Data is at 25°C. ac values are rms. kHz (kilohertz) = kc/s.  
 2) For series connected coils  $R_f = 4x$ ,  $X_f = 4x$  and  $I_{fmax} = .5x$  values shown.  
 Underlined models are standard stock items.

HQ-3100 Series Hall-Pak Multipliers consist of a Hall element located in the gap of a laminated silicon steel core with two identical field coils. A current flowing through the coils generates a magnetic field in the gap. The Hall element is a magneto sensitive semiconductor with four terminals, providing a voltage proportional to the product of the magnetic field in which it is placed and the current flowing through it. The output voltage of the multiplier is therefore proportional to the product of the field input current and the Hall input current.

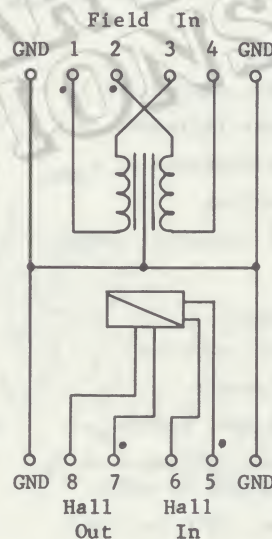
HQ-3100 Series Multipliers are epoxy potted in a nylon-phenolic case  $1\frac{11}{16}" \times 1\frac{5}{8}" \times 1\frac{1}{16}"$  with #20 AWG tinned, 2" long terminal leads on a .1" grid for printed circuit board mounting. Weight 4-1/2 oz.

Typical applications are: analog multiplier, dc to ac convertor, chopper, function generator, squarer, level regulator, modulator, discriminator, dc and ac wattmeter.



**SCHEMATIC**

Parallel Coils: Short 1-2 & 3-4  
Series Coils: Short 2-3



Electrically equivalent models are available in the HM-3000 Series, featuring a hermetically sealed steel case and plug-in header.

Points to consider in Hall multiplier applications:

1. The Hall output voltage is proportional to the product of the input currents. The input currents must therefore be proportional to the quantities to be multiplied.
2. The field input circuit is reactive. Maximum driving power is approximately .5 W. Maximum driving VA is determined by the highest frequency in the input signal.
3. The Hall input circuit is resistive. Maximum driving power is approximately .25 W. A high impedance source will reduce the influence of temperature and magneto resistance.
4. The field input circuit is isolated from the Hall circuits. The core ground provides electrostatic shielding.
5. The Hall input circuit is not isolated from the Hall output circuit. Only one of these two circuits can be grounded.

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# HALL-PAK MULTIPLIERS SPECIFICATIONS

HM-3500  
SERIES

|                                                                                                                                        |                                               |                    |                    |                    |               |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--------------------|--------------------|--------------------|---------------|
| Type 3 - not compensated<br>Type 2 - temperature compensated<br>Type 1 - error voltages compensated<br>Type 0 - completely compensated |                                               | HM-3501<br>HM-3500 | HM-3521<br>HM-3520 | HM-3541<br>HM-3540 | Unit 1)       |
| <u>Magnetic Field Input</u>                                                                                                            | data for parallel connected field coils<br>2) |                    |                    |                    |               |
| Resistance, approx. $R_f$                                                                                                              | 1                                             | 2                  | 8                  |                    | mΩ            |
| Temperature influence on $R_f$                                                                                                         | .39                                           | .39                | .39                |                    | %/°C          |
| Reactance, approx. $X_f$                                                                                                               | 20                                            | 80                 | 320                |                    | mΩ/kHz        |
| Current rating $I_{fmax}$                                                                                                              | <u>40</u>                                     | <u>20</u>          | <u>10</u>          |                    | A             |
| Practical freq. range at $I_{fmax}$ dc to                                                                                              | 1                                             | .5                 | .25                |                    | kHz           |
| <u>Hall Input</u>                                                                                                                      | all models                                    |                    |                    |                    |               |
| Resistance, approx. at $I_f = 0$ $R_{in}$                                                                                              |                                               | 20                 |                    |                    | Ω             |
| Temperature influence on $R_{in}$ , approx.                                                                                            |                                               | <+.02              |                    |                    | %/°C          |
| Magneto resistance at $I_{fmax}$ $\rho_B \sim I_f^2$                                                                                   |                                               | <+2.5              |                    |                    | % of $R_{in}$ |
| Current rating $I_{cmax}$                                                                                                              |                                               | <u>330</u>         |                    |                    | mA            |
| Practical frequency range dc to                                                                                                        |                                               | 100                |                    |                    | kHz           |
| <u>Hall Output</u>                                                                                                                     | Type 0                                        | Type 1             | Type 2             | Type 3             |               |
| Resistance, approx. $R_{out}$                                                                                                          | 10                                            | 2.5                |                    |                    | Ω             |
| Load resistance $R_l$                                                                                                                  | 50                                            | >30                |                    |                    | Ω             |
| Output at max. inputs $V_H \sim I_f \times I_c$                                                                                        | <u>&gt;200</u>                                | <u>&gt;250</u>     |                    |                    | mV            |
| Temperature influence on $V_H$ ,<br>-ambient 0°C to +50°C                                                                              | <±.5                                          | <±3                |                    |                    | %             |
| -ambient -25°C to +75°C                                                                                                                | <±1                                           | <±6                |                    |                    | %             |
| <u>Hall Output vs. Field Input</u>                                                                                                     |                                               |                    |                    |                    |               |
| Linearity error, at constant $I_c$ $F_{fs}$                                                                                            | <.5                                           | <.5                |                    |                    | % FS          |
| Remanent residual after $I_f$ dc max. to 0                                                                                             | <.5                                           | <.5                |                    |                    | % FS          |
| Phase shift, approx. $V_H$ lags $I_f$                                                                                                  | 3                                             | 3                  |                    |                    | deg/kHz       |
| Frequency response, approx.                                                                                                            | -.3                                           | -.3                |                    |                    | dB/kHz        |
| Inductive error voltage at $I_{fmax}$ $V_{B2} \sim I_f$                                                                                | <.2                                           | <.2                |                    |                    | mV/kHz        |
| <u>Hall Output vs. Hall Input</u>                                                                                                      |                                               |                    |                    |                    |               |
| Linearity error, at constant $I_f$ $F_{fs}$                                                                                            | <.25                                          | <.25               |                    |                    | % FS          |
| Resistive error voltage at $I_{cmax}$ $V_M \sim I_c$                                                                                   | <.3                                           | <.3                |                    |                    | mV            |
| Thermal error voltage at $I_{cmax}$ $V_T \sim I_c$                                                                                     | <.3                                           | <.3                |                    |                    | mV dc         |

NOTES 1) Data is at 25°C. ac values are rms. kHz (kilohertz) = kc/s.

2) For series connected coils  $R_f = 4x$ ,  $X_f = 4x$ ,  $I_{fmax} = .5x$  and frequency range = .5x values shown.

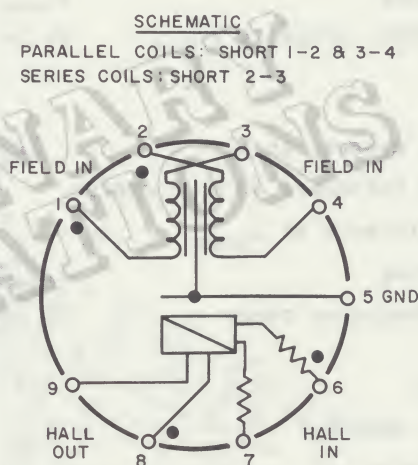
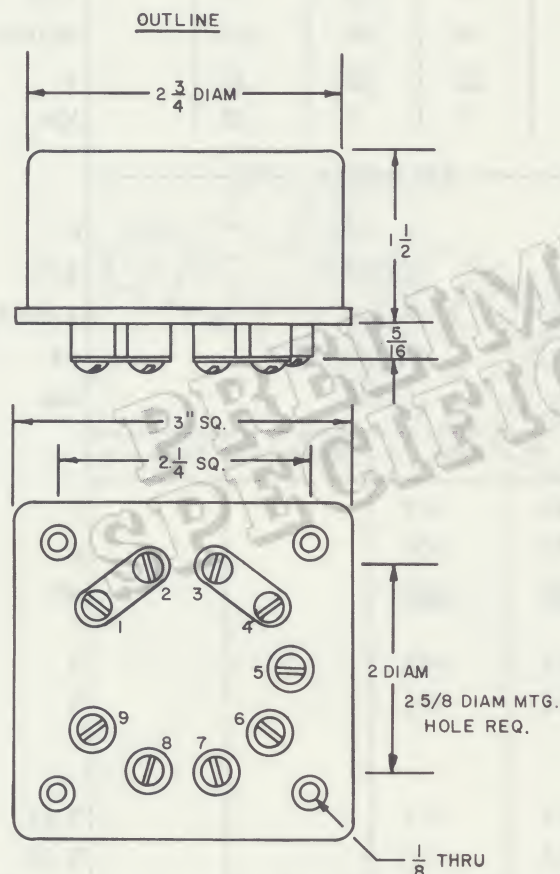
Underlined models are standard stock items.



HM-3500 Series Hall-Pak Multipliers consist of a Hall element located in the gap of a laminated silicon steel core with two identical field coils. A current flowing through the coils generates a magnetic field in the gap. The Hall element is a magneto sensitive semiconductor with four terminals, providing a voltage proportional to the product of the magnetic field in which it is placed and the current flowing through it. The output voltage of the multiplier is therefore proportional to the product of the field input current and the Hall input current.

HM-3500 Series Multipliers are epoxy potted in a steel case 2-3/4" diam by 1-3/8", mounted on a phenolic baseplate 3" x 3" with nine 11/32" diam screw terminals, two current terminal links and four 1/8" mounting holes. Weight 12 oz.

Typical applications are: transducer for measuring power in medium current dc or low frequency ac power systems, isolated current sensor in medium current dc systems.



Similar models, featuring field frequency ranges from dc to maximum 100 kHz and maximum output at least 50 mV are available in the HM-4500 Series.

Points to consider in Hall multiplier applications:

1. The Hall output voltage is proportional to the product of the input currents. The input currents must therefore be proportional to the quantities to be multiplied.
2. The field input circuit is reactive. Maximum driving power is approximately 1 W. Maximum driving VA is determined by the highest frequency in the input signal.
3. The Hall input circuit is resistive. Maximum driving power is approximately 2 W. A high impedance source will reduce the influence of temperature and magneto resistance.
4. The field input circuit is isolated from the Hall circuits. The core ground provides electrostatic shielding.
5. The Hall input circuit is not isolated from the Hall output circuit. Only one of these two circuits can be grounded.

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HQ-4100  
SERIES

|                                                                    |                                                  |                                         |         |            |                    |                      |
|--------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------|---------|------------|--------------------|----------------------|
| Type 3 - not compensated                                           |                                                  |                                         |         |            | Unit <sup>1)</sup> |                      |
| Type 2 - temperature compensated                                   |                                                  |                                         |         |            |                    |                      |
| Type 1 - error voltages compensated                                | HQ-4131                                          |                                         | HQ-4151 | HQ-4171    |                    |                      |
| Type 0 - completely compensated                                    | HQ-4130                                          |                                         | HQ-4150 | HQ-4170    |                    |                      |
| <u>Magnetic Field Input</u>                                        |                                                  | data for parallel connected field coils |         |            |                    |                      |
| Resistance, approx.                                                | R <sub>f</sub>                                   | .05                                     |         | .75        | 23                 | Ω                    |
| Temperature influence on R <sub>f</sub>                            |                                                  | + .39                                   |         | + .39      | + .39              | %/°C                 |
| Reactance, approx.                                                 | X <sub>f</sub>                                   | .25                                     |         | 6          | 160                | Ω/kHz                |
| Current rating                                                     | I <sub>fmax</sub>                                | <u>2500</u>                             |         | <u>500</u> | <u>100</u>         | mA                   |
| Practical freq. range at I <sub>fmax</sub>                         | dc to                                            | 500                                     |         | 100        | 20                 | kHz                  |
| <u>Hall Input</u>                                                  |                                                  | <u>all models</u>                       |         |            |                    |                      |
| Resistance, approx. at I <sub>f</sub> = 0                          | R <sub>in</sub>                                  |                                         |         | 2.5        |                    | Ω                    |
| Temperature influence on R <sub>in</sub> , approx.                 |                                                  |                                         |         | + .15      |                    | %/°C                 |
| Magneto resistance at I <sub>fmax</sub>                            | ρ <sub>B</sub> ~ I <sub>f</sub> <sup>2</sup>     |                                         |         | <+2        |                    | % of R <sub>in</sub> |
| Current rating                                                     | I <sub>cmax</sub>                                |                                         |         | <u>300</u> |                    | mA                   |
| Practical frequency range                                          | dc to                                            |                                         |         | 500        |                    | kHz                  |
| <u>Hall Output</u>                                                 |                                                  | Type 0                                  | Type 1  | Type 2     | Type 3             |                      |
| Resistance, approx.                                                | R <sub>out</sub>                                 | 10                                      | 2.5     |            |                    | Ω                    |
| Load resistance                                                    | R <sub>L</sub>                                   | 50                                      | >30     |            |                    | Ω                    |
| Output at max. inputs                                              | V <sub>H</sub> ~ I <sub>f</sub> × I <sub>c</sub> | >50                                     | >60     |            |                    | mV                   |
| Temperature influence on V <sub>H</sub> ,<br>-ambient 0°C to +50°C |                                                  | <±.5                                    | <±3     |            |                    | %                    |
| -ambient -25°C to +75°C                                            |                                                  | <±1                                     | <±6     |            |                    | %                    |
| <u>Hall Output vs. Field Input</u>                                 |                                                  |                                         |         |            |                    |                      |
| Linearity error, at constant I <sub>c</sub>                        | F <sub>fs</sub>                                  | <.3                                     | <.3     |            |                    | % FS                 |
| Remanent residual after I <sub>f</sub> dc max. to 0                |                                                  | <.3                                     | <.3     |            |                    | % FS                 |
| Phase shift, approx.                                               | V <sub>H</sub> lags I <sub>f</sub>               | <.1                                     | <.1     |            |                    | deg/kHz              |
| Frequency response, approx.                                        |                                                  | --                                      | --      |            |                    | dB/kHz               |
| Inductive error voltage at I <sub>fmax</sub>                       | V <sub>B2</sub> ~ I <sub>f</sub>                 | <.005                                   | <.005   |            |                    | mV/kHz               |
| <u>Hall Output vs. Hall Input</u>                                  |                                                  |                                         |         |            |                    |                      |
| Linearity error, at constant I <sub>f</sub>                        | F <sub>fs</sub>                                  | <.25                                    | <.25    |            |                    | % FS                 |
| Resistive error voltage at I <sub>cmax</sub>                       | V <sub>M</sub> ~ I <sub>c</sub>                  | <.1                                     | <.1     |            |                    | mV                   |
| Thermal error voltage at I <sub>cmax</sub>                         | V <sub>T</sub> ~ I <sub>c</sub> <sup>2</sup>     | <.2                                     | <.2     |            |                    | mV dc                |

NOTES 1) Data is at 25°C. ac values are rms. kHz (kilohertz) = kc/s.

2) For series connected coils  $R_f = 4x$ ,  $X_f = 4x$ ,  $I_{fmax} = .5x$  and frequency range = .5x values shown.

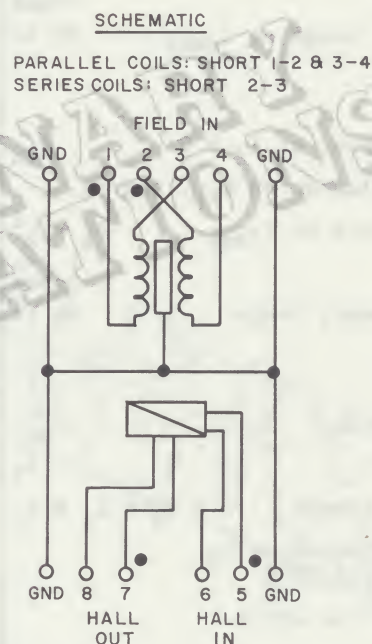
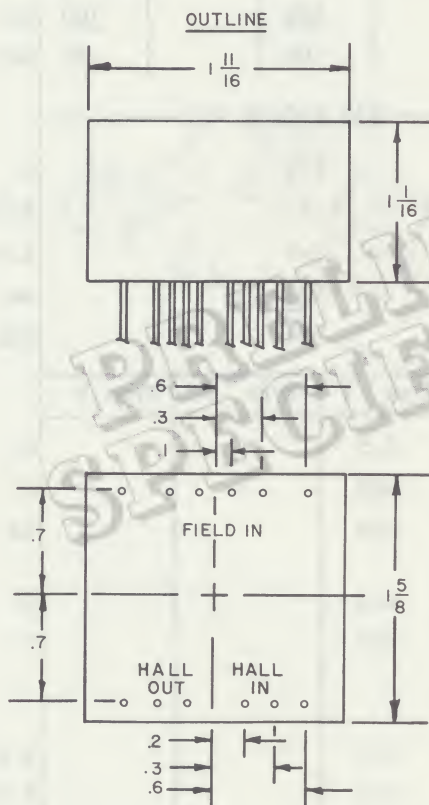
Underlined models are standard stock items.



HQ-4100 Series Hall-Pak Multipliers consist of a Hall element located in the gap of a ferrite core with two identical field coils. A current flowing through the coils generates a magnetic field in the gap. The Hall element is a magneto sensitive semiconductor with four terminals, providing a voltage proportional to the product of the magnetic field in which it is placed and the current flowing through it. The output voltage of the multiplier is therefore proportional to the product of the field input current and Hall input current.

HQ-4100 Series Multipliers are epoxy potted in a nylon-phenolic case  $1\frac{11}{16}" \times 1\frac{5}{8}" \times 1\frac{1}{16}"$  with #20 AWG tinned, 2" long terminal leads on a 0.1" grid for printed circuit board mounting. Weight 3 oz.

Typical applications are: analog multiplier, dc to ac convertor, chopper, function generator, squarer, level regulator, modulator, discriminator, power measuring transducer and, in general, all applications that require a field input circuit with a wide pass band and extremely good linearity.



Electrically equivalent models are available in the HM-4000 Series, featuring a hermetically sealed steel case and plug-in header.

Points to consider in Hall multiplier applications:

1. The Hall output voltage is proportional to the product of the input currents. The input currents must therefore be proportional to the quantities to be multiplied.
2. The field input circuit is reactive. Maximum driving power is approximately .5 W. Maximum driving VA is determined by the highest frequency in the input signal.
3. The Hall input circuit is resistive. Maximum driving power is approximately .25 W. A high impedance source will reduce the influence of temperature and magneto resistance.
4. The field input circuit is isolated from the Hall circuits. The core ground provides electrostatic shielding.
5. The Hall input circuit is not isolated from the Hall output circuit. Only one of these two circuits can be grounded.

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# HALL-PAK MULTIPLIERS SPECIFICATIONS

HM-4500  
SERIES

|                                                                                                                                        |                                               |                    |                    |                    |                    |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--------------------|--------------------|--------------------|--------------------|
| Type 3 - not compensated<br>Type 2 - temperature compensated<br>Type 1 - error voltages compensated<br>Type 0 - completely compensated |                                               | HM-4501<br>HM-4500 | HM-4521<br>HM-4520 | HM-4541<br>HM-4540 | Unit <sup>1)</sup> |
| <u>Magnetic Field Input</u>                                                                                                            | data for parallel connected field coils<br>2) |                    |                    |                    |                    |
| Resistance, approx. $R_f$                                                                                                              | .5                                            | 2                  | 8                  |                    | mΩ                 |
| Temperature influence on $R_f$                                                                                                         | + .39                                         | + .39              | + .39              |                    | %/°C               |
| Reactance, approx. $X_f$                                                                                                               | 1                                             | 4                  | 16                 |                    | mΩ/kHz             |
| Current rating $I_{fmax}$                                                                                                              | <u>40</u>                                     | <u>20</u>          | <u>10</u>          |                    | A                  |
| Practical freq. range at $I_{fmax}$ dc to                                                                                              | 100                                           | 50                 | 25                 |                    | kHz                |
| <u>Hall Input</u>                                                                                                                      | all models                                    |                    |                    |                    |                    |
| Resistance, approx. at $I_f = 0$ $R_{in}$                                                                                              |                                               | 20                 |                    |                    | Ω                  |
| Temperature influence on $R_{in}$ , approx.                                                                                            |                                               | <+.02              |                    |                    | %/°C               |
| Magneto resistance at $I_{fmax}$ $\rho_B \sim I_f^2$                                                                                   |                                               | <+.2               |                    |                    | % of $R_{in}$      |
| Current rating $I_{cmax}$                                                                                                              |                                               | <u>300</u>         |                    |                    | mA                 |
| Practical frequency range dc to                                                                                                        |                                               | 100                |                    |                    | kHz                |
| <u>Hall Output</u>                                                                                                                     | Type 0                                        | Type 1             | Type 2             | Type 3             |                    |
| Resistance, approx. $R_{out}$                                                                                                          | 10                                            | 2.5                |                    |                    | Ω                  |
| Load resistance $R_L$                                                                                                                  | 50                                            | >30                |                    |                    | Ω                  |
| Output at max. inputs $V_H \sim I_f \times I_c$                                                                                        | >50                                           | >60                |                    |                    | mV                 |
| Temperature influence on $V_H$ ,<br>-ambient 0°C to +50°C                                                                              | <±.5                                          | <±3                |                    |                    | %                  |
| -ambient -25°C to +75°C                                                                                                                | <±1                                           | <±6                |                    |                    | %                  |
| <u>Hall Output vs. Field Input</u>                                                                                                     |                                               |                    |                    |                    |                    |
| Linearity error, at constant $I_c$ $F_{fs}$                                                                                            | <.3                                           | <.3                |                    |                    | % FS               |
| Remanent residual after $I_f$ dc max. to 0                                                                                             | <.3                                           | <.3                |                    |                    | % FS               |
| Phase shift, approx. $V_H$ lags $I_f$                                                                                                  | <.1                                           | <.1                |                    |                    | deg/kHz            |
| Frequency response, approx.                                                                                                            | --                                            | --                 |                    |                    | dB/kHz             |
| Inductive error voltage at $I_{fmax}$ $V_{B2} \sim I_f$                                                                                | <.1                                           | <.1                |                    |                    | mV/kHz             |
| <u>Hall Output vs. Hall Input</u>                                                                                                      |                                               |                    |                    |                    |                    |
| Linearity error, at constant $I_f$ $F_{fs}$                                                                                            | <.25                                          | <.25               |                    |                    | % FS               |
| Resistive error voltage at $I_{cmax}$ $V_M \sim I_c$                                                                                   | <.3                                           | <.3                |                    |                    | mV                 |
| Thermal error voltage at $I_{cmax}$ $V_T \sim I_c^2$                                                                                   | <.3                                           | <.3                |                    |                    | mV dc              |

NOTES 1) Data is at 25°C. ac values are rms. kHz (kilohertz) = kc/s.

2) For series connected coils  $R_f = 4x$ ,  $X_f = 4x$ ,  $I_{fmax} = .5x$  and frequency range = .5x values shown.

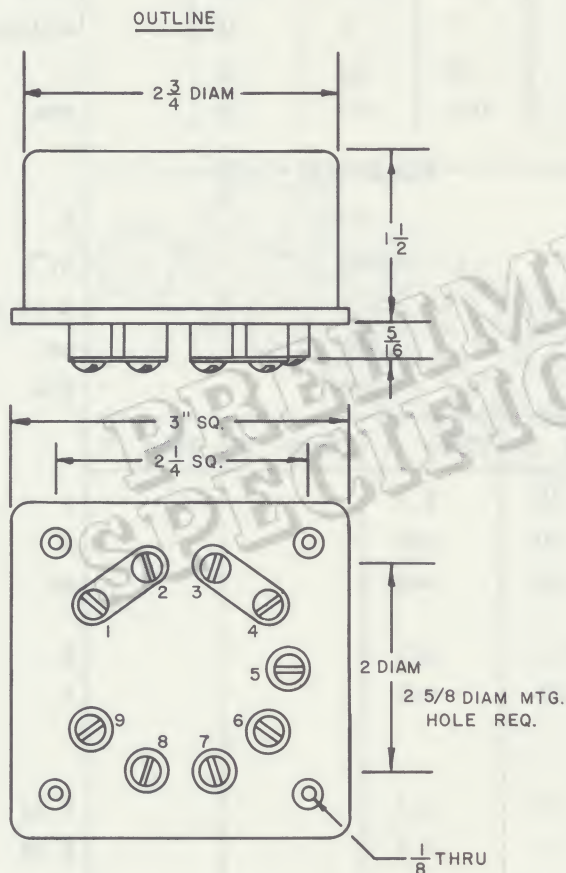
Underlined models are standard stock items.



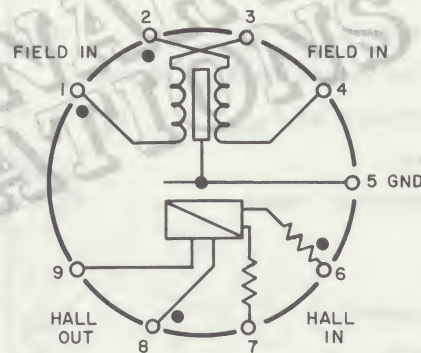
HM-4500 Series Hall-Pak Multipliers consist of a Hall element located in the gap of a ferrite core with two identical field coils. A current flowing through the coils generates a magnetic field in the gap. The Hall element is a magneto sensitive semiconductor with four terminals, providing a voltage proportional to the product of the magnetic field in which it is placed and the current flowing through it. The output voltage of the multiplier is therefore proportional to the product of the field input current and the Hall input current.

HM-4500 Series Multipliers are epoxy potted in a steel case  $2\frac{3}{4}$ " diam x  $1\frac{3}{8}$ ", mounted on a phenolic base plate 3" x 3" with nine  $11/32$ " diam screw terminals, two current terminal links, and four  $1/8$ " mounting holes. Weight 12 oz.

Typical applications are: transducer for measuring power in medium current pulsating dc or medium frequency ac power systems, isolated current sensor with fast response in medium current dc systems.



SCHEMATIC  
PARALLEL COILS: SHORT 1-2 & 3-4  
SERIES COILS: SHORT 2-3



Similar models, featuring field frequency ranges dc to maximum 1 kHz and maximum output at least 200 mV are available in the HM-3500 Series.

Points to consider in Hall multiplier applications:

1. The Hall output voltage is proportional to the product of the input currents. The input currents must therefore be proportional to the quantities to be multiplied.
2. The field input circuit is reactive. Maximum driving power is approximately 1 W. Maximum driving VA is determined by the highest frequency in the input signal.
3. The Hall input circuit is resistive. Maximum driving power is approximately 2 W. A high impedance source will reduce the influence of temperature and magneto resistance.
4. The field input circuit is isolated from the Hall circuits. The core ground provides electrostatic shielding.
5. The Hall input circuit is not isolated from the Hall output circuit. Only one of these two circuits can be grounded.

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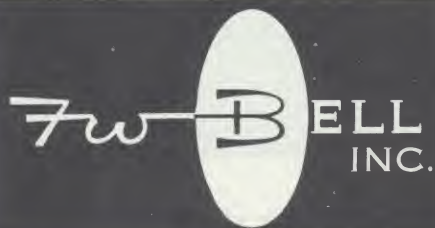
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# HALL-PAK MULTIPLIER SPECIFICATIONS

HM-4000  
SERIES

|                                                                                                                                        |                           |                    |           |                    |        |                             |
|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------------|-----------|--------------------|--------|-----------------------------|
| Type 3 - not compensated<br>Type 2 - temperature compensated<br>Type 1 - error voltages compensated<br>Type 0 - completely compensated |                           |                    |           |                    |        | Unit 1)                     |
|                                                                                                                                        |                           | HM-4031<br>HM-4030 |           | HM-4051<br>HM-4050 |        | HM-4071<br>HM-4070          |
| data for parallel connected field coils                                                                                                |                           |                    |           |                    |        |                             |
| 2)                                                                                                                                     |                           |                    |           |                    |        |                             |
| Magnetic Field Input                                                                                                                   |                           |                    |           |                    |        |                             |
| Resistance, approx.                                                                                                                    | $R_f$                     | .05                |           | .75                |        | 23 $\Omega$                 |
| Temperature influence on $R_f$                                                                                                         |                           | + .39              |           | + .39              |        | + .39 $\%/^{\circ}\text{C}$ |
| Reactance, approx.                                                                                                                     | $X_f$                     | .25                |           | 6                  |        | 160 $\Omega/\text{kHz}$     |
| Current rating                                                                                                                         | $I_{fmax}$                | <u>2500</u>        |           | <u>500</u>         |        | <u>100</u> mA               |
| Practical freq. range at $I_{fmax}$                                                                                                    | dc to                     | 500                |           | 100                |        | 20 kHz                      |
| all models                                                                                                                             |                           |                    |           |                    |        |                             |
| Hall Input                                                                                                                             |                           |                    |           |                    |        |                             |
| Resistance, approx. at $I_f = 0$                                                                                                       | $R_{in}$                  |                    |           | 2.5                |        | $\Omega$                    |
| Temperature influence on $R_{in}$ , approx.                                                                                            |                           |                    |           | + .15              |        | $\%/^{\circ}\text{C}$       |
| Magneto resistance at $I_{fmax}$                                                                                                       | $\rho_B \sim I_f^2$       |                    |           | < +2               |        | % of $R_{in}$               |
| Current rating                                                                                                                         | $I_{cmax}$                |                    |           | <u>300</u>         |        | mA                          |
| Practical frequency range                                                                                                              | dc to                     |                    |           | 500                |        | kHz                         |
| Hall Output                                                                                                                            |                           |                    |           |                    |        |                             |
|                                                                                                                                        |                           | Type 0             | Type 1    | Type 2             | Type 3 |                             |
| Resistance, approx.                                                                                                                    | $R_{out}$                 | 10                 | 2.5       |                    |        | $\Omega$                    |
| Load resistance                                                                                                                        | $R_l$                     | 50                 | >30       |                    |        | $\Omega$                    |
| Output at max. inputs                                                                                                                  | $V_H \sim I_f \times I_c$ | >50                | >60       |                    |        | mV                          |
| Temperature influence on $V_H$ :                                                                                                       |                           |                    |           |                    |        |                             |
| - ambient 0 C to +50 C                                                                                                                 |                           | < $\pm 1.5$        | < $\pm 3$ |                    |        | %                           |
| - ambient -25 C to +75 C                                                                                                               |                           | < $\pm 1$          | < $\pm 6$ |                    |        | %                           |
| Hall Output vs. Field Input                                                                                                            |                           |                    |           |                    |        |                             |
| Linearity error, at constant $I_c$                                                                                                     | $F_{fs}$                  | < .3               | < .3      |                    |        | % FS                        |
| Remanent residual after $I_f$ dc max. to 0                                                                                             |                           | < .3               | < .3      |                    |        | % FS                        |
| Phase shift, approx.                                                                                                                   | $V_H$ lags $I_f$          | < .1               | < .1      |                    |        | deg/kHz                     |
| Frequency response, approx.                                                                                                            |                           | --                 | --        |                    |        | dB/kHz                      |
| Inductive error voltage at $I_{fmax}$                                                                                                  | $V_{B2} \sim I_f$         | < .005             | < .005    |                    |        | mV/kHz                      |
| Hall Output vs. Hall Input                                                                                                             |                           |                    |           |                    |        |                             |
| Linearity error, at constant $I_f$                                                                                                     | $F_{fs}$                  | < .25              | < .25     |                    |        | % FS                        |
| Resistive error voltage at $I_{cmax}$                                                                                                  | $V_M \sim I_c$            | < .1               | < .1      |                    |        | mV                          |
| Thermal error voltage at $I_{cmax}$                                                                                                    | $V_T \sim I_c^2$          | < .2               | < .2      |                    |        | mV dc                       |

NOTES 1) Data is at 25°C. ac values are rms. kHz (kilohertz) = kc/s.

2) For series connected coils  $R_f = 4x$ ,  $X_f = 4x$ ,  $I_{fmax} = .5x$  and freq. range = .5x values shown.

Underlined models are standard stock items.